

## CHAPTER 8

# CARBON DIOXIDE

***Learning Objective: Upon completion of this chapter, you will be able to describe, inspect, recharge, and perform maintenance on carbon dioxide cylinders and transfer units.***

Carbon dioxide is a heavy, colorless gas. The chemical symbol for carbon dioxide is  $\text{CO}_2$ . You will find that most people use this symbol when referring to carbon dioxide.

$\text{CO}_2$  doesn't burn and does not support combustion; therefore, it makes a fine fire-fighting agent. It is strongly recommended for use on electrical fires. The servicing of fire-fighting equipment is not part of the PR rate, and so this text does not cover fire extinguishers.

As a PR you deal with life raft and life preserver  $\text{CO}_2$  cylinders, which you weigh, recharge, and repair.

Carbon dioxide is ordinarily procured from local commercial sources. It is stored in standard supply cylinders that contain 50 pounds of carbon dioxide when full.

Before learning how to recharge  $\text{CO}_2$  cylinders, you should be familiar with the following information:

In its gas form, carbon dioxide is 1.53 times heavier than air.  $\text{CO}_2$  gas can be converted into a liquid by applying pressure to the gas. With as little as 600 psi at a temperature below  $88^\circ\text{F}$ , the  $\text{CO}_2$  gas can be converted into a liquid and stored in that state until it is subjected to the outside atmosphere. By opening the cylinder valve and letting the carbon dioxide escape into the atmosphere, you cause a rapid drop

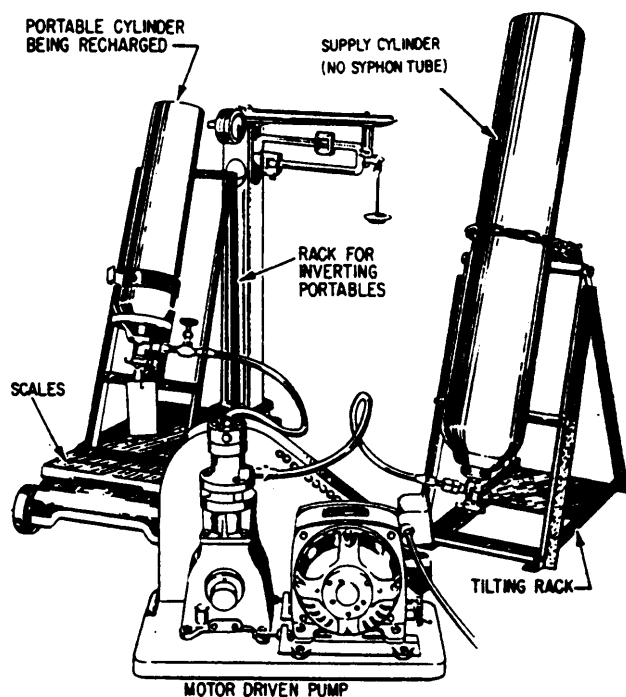
in pressure. As the  $\text{CO}_2$  escapes through the small opening, it forms carbon dioxide snow. This snow, when compressed into blocks or cubes, is known as dry ice. At atmospheric pressure, dry ice will remain at  $-110^\circ\text{F}$ , directly evaporating into  $\text{CO}_2$  gas.  $\text{CO}_2$  exists as a liquid only when under pressure.

Whenever you are working with  $\text{CO}_2$  in any of its three stages—gas, liquid, or dry ice, you should be aware that small percentages of  $\text{CO}_2$  in the air causes tiredness and perhaps headaches. Experiments have shown that a 3-percent concentration in the air doubles your breathing effort, 5 percent causes panting, 8 percent causes marked distress, and 10 percent causes unconsciousness very quickly.

Treatment of exposed personnel includes removing them from the  $\text{CO}_2$ -laden atmosphere, artificial resuscitation, administering oxygen, and keeping the patient warm.

### **$\text{CO}_2$ RECHARGE EQUIPMENT**

Carbon dioxide recharge equipment is manufactured for the Navy by several different companies. The two most widely used units are those manufactured by the C-O-TWO Company of Newark, New Jersey (do not confuse this company with the chemical symbol  $\text{CO}_2$ ) and the Walter Kidde Company of Belleville, New Jersey.



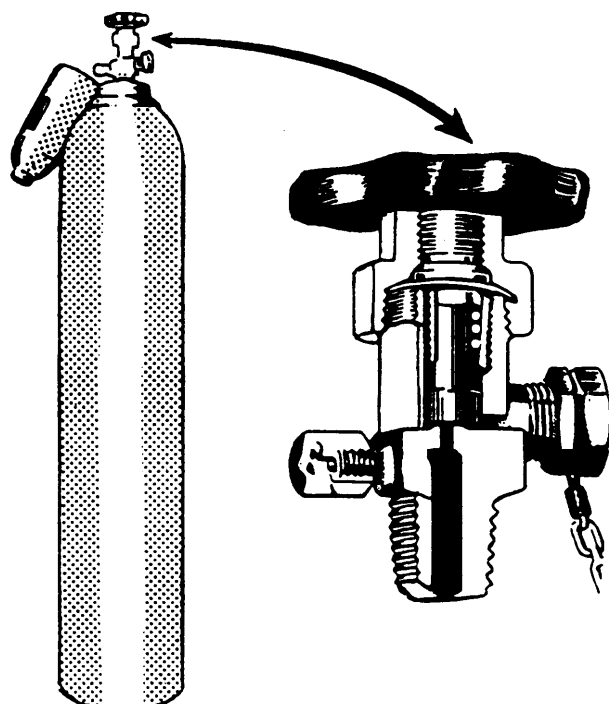
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**Figure 8-1.—C-O-TWO recharge or transfer unit (supply cylinder without a syphon tube).**

A typical C-O-TWO recharge unit is shown in figure 8-1 and consists of a supply cylinder containing 50 pounds of CO<sub>2</sub>, a tilting rack for inverting the supply cylinder, a motor-driven pump, a rack for inverting the cylinder being recharged, a scale for determining the weight of the cylinder being recharged, and the necessary high-pressure hoses, control valves, adapters, etc., to properly hookup the equipment. The two units are covered in detail in the *PR 1 & C*.

Before learning the operation of any specific type of recharge equipment, you should be familiar with the following general information, which applies to all units.

Carbon dioxide recharge equipment pumps CO<sub>2</sub> in its liquid state only, and the amount of liquid CO<sub>2</sub> a cylinder contains varies with the temperature and pressure. For example, a standard 50-pound supply cylinder contains approximately 38 pounds of liquid CO<sub>2</sub> and 12 pounds of gaseous CO<sub>2</sub> at a temperature of 70°F. It follows, then, that the cooler the supply cylinder and cylinder being recharged, the more efficient the operation of the transfer equipment. For this same reason, the time required to recharge an empty cylinder increases with the temperature of the cylinders.



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**Figure 8-2.—CO<sub>2</sub> supply cylinder.**

When recharging a cylinder, it remains cooler and may be filled faster if inverted, rather than left in an upright position. Large cylinders, which are impractical to invert, may be placed in a horizontal position for charging.

Standard commercial supply cylinders in 50-pound sizes are obtained with or without a syphon tube. When transferring from a cylinder without a syphon tube, the cylinder must be inverted. Supply cylinders with syphon tubes should be maintained in an upright position, not more than 60 degrees from vertical.

### **CO<sub>2</sub> SUPPLY CYLINDERS**

Figure 8-2 illustrates the standard supply cylinder used universally in recharging various types of CO<sub>2</sub> cylinders. A cutaway view of the cylinder valve is also shown. Table 8-1 lists some of the most pertinent data concerning supply cylinders.

### **INSPECTING CO<sub>2</sub> CYLINDERS AND RECHARGING**

Cylinders, including some of those of new manufacture, continue to bear ICC markings and,

**Table 8.1.—Specifications On Supply Cylinders**

Capacity at normal pressure and temperature* . . . . .	50 pounds
Working pressure . . . . .	1,800 to 2,015 psi
ICC specification . . . . .	ICC3A
Dimensions (approx.) . . . . .	Diameter, 8 1/2 inches; length, 51 inches
Weight, empty . . . . .	110-115 pounds
Outlet connection . . . . .	3/4 inch

\* Temperature of 68° - 70°F and atmospheric pressure.

until amendment to Department of Transportation (DoT) regulations, such markings will remain in use.

Compressed gas cylinders, including CO<sub>2</sub> cylinders must not be refilled if the hydrostatic test date has expired. This date, expressed by month-year, e.g., 8-70, is stamped on the shoulder of the cylinder each time the cylinder is retested. The hydrostatic test date is considered as having expired if the latest date stamped on the cylinder precedes the current date by more than 5 years.

Cylinders that do not exceed 2 inches in outside diameter and that are less than 2 feet long are exempt from the hydrostatic retest.

The hydrostatic retest date applies to multi-place life raft cylinders; if the cylinder is due for a test, discharge and disconnect the cylinder. Obtain a new cylinder from supply as a replacement, and forward the old cylinder to an activity capable of conducting a hydrostatic test.

Many nonshatterable cylinders are identified by the words NONSHATTERABLE, NONSHAT, or SHATTERPROOF stamped (not stenciled) on the shoulder or side of the cylinder. Substitution of a "shatterable" for a "non-scatterable" cylinder is not authorized.

Personnel who handle compressed gas cylinders must be familiar with the color coding of cylinders. Color coding is provided as a hazard warning, and should not be used by itself to identify the contents of a cylinder. In the event of

conflict with other markings, or doubt as to the contents, the cylinder should be returned to the local supply activity, (non-RFI).

All carbon dioxide inflation cylinders must be painted gray, and markings must be in black letters 1/4-inch high. The information must include gross weight, tare weight, weight of carbon dioxide, and date of latest recharge. Paint and stencil the cylinder as required, and ensure that all markings are included as necessary.

Ensure that all carbon dioxide cylinders used for life raft inflation assemblies received from supply, except those used on the one-man rafts, have syphon tubes installed.

Gently tap the inverted cylinder with a small piece of wood. If any rust or other contamination falls from the cylinder, reject that cylinder, and draw another cylinder from supply; repeat the contamination check. Replace the stem in the inflation assembly valve, install a new sealing washer, and thread the inflation assembly valve onto the cylinder and tighten.

Inspection for deterioration of the cylinder will consist of a visual examination for the defects listed below.

Cylinders with defects that approximate the physical dimensions indicated in the following list will be condemned and returned to supply.

1. Corrosion pits in a general corrosion area that exceed a depth of 1/32-inch, or isolated pits not in a general corrosion area that exceed a depth of 5/64-inch.

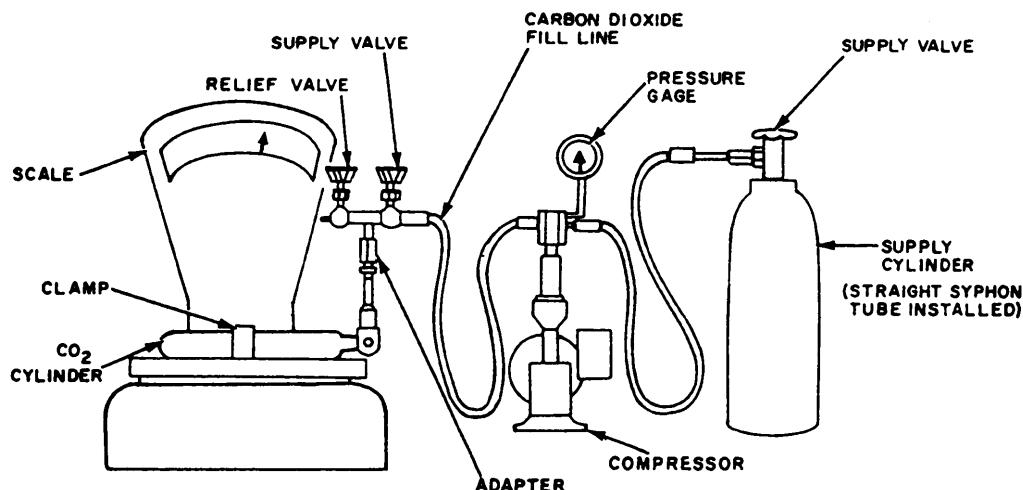
2. Dents that exceed a depth of 1/16-inch, or whose major diameter is more than 32 times the depth.

3. Cuts or gouges more than 1/16-inch, or whose major diameter is more than 32 times the depth.

4. Visible arc or torch burns.

5. Evidence that the cylinder has been in a fire.

6. Discernible bulges.



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Figure 8-3.—CO<sub>2</sub> recharging schematic.

Now that you have inspected the CO<sub>2</sub> cylinder, you are ready to recharge the bottle. Figure 8-3 shows a recharging setup. Notice in the figure that you need scales, a recharge pump, a supply cylinder, and the necessary lines and valves. Proceed as follows:

1. Place the CO<sub>2</sub> cylinder on the scales.

**NOTE: An accurate scale with a capacity of 100 pounds is necessary. The scale should have 1/100 pound graduations.**

2. Weigh and record tare weight (empty weight of cylinder, valve and cable assembly) of the inflation assembly.

3. Install proper charging adapter on the inflation assembly.

4. Secure the inflation assembly to the weighing pan located on the scales before applying any pressure to the cylinder being recharged.

5. Open the supply cylinder valve, fill line valve, and relief valve. This is done to purge (get the air out of) the complete line. Once the line is purged, close the fill line valve and the relief valve. You must be careful when purging the line; you are dealing with a high pressure. If you do not secure the fill line before you apply pressure, the line may start a whipping action and damage anything or anyone that it hits.

6. After purging the line, connect the fill line to the inflation assembly. Ensure that the line is free from contact with any objects along the entire distance from the compressor to the charging

Table 8-2.—Carbon Dioxide Charge

RAFT TYPE	WEIGHT (IN Lbs) OF CO <sub>2</sub>
LR-1	0.49 to 0.51
LRU-7/P	0.49 to 0.51
LRU-12/A	3.21 to 3.29
LRU-13/A	4.64 to 4.76
LRU-14/A	4.74 to 4.86
LRU-15/A	9.14 to 9.26

adapter. If the line does not hang free, accurate weight reading cannot be obtained. At this time, you must zero your scales. By zeroing the scales, you will be able to recharge the exact amount of CO<sub>2</sub> into the inflation assembly. See table 8-2 for carbon dioxide charges.

7. Ensure that the inflation assembly valve is open. If it is closed, you cannot recharge the assembly.

8. Open the fill line valve slowly until you hear CO<sub>2</sub> flowing through the line and into the inflation assembly, and the scale's indicator shows the recharging cylinder is gaining weight.

9. Allow carbon dioxide to cascade (flow freely) from the supply cylinder until the scales

indicate that the cylinder being recharged isn't receiving anymore CO<sub>2</sub>. If you haven't reached the gross weight required (tare weight plus weight of charge) start the compressor and complete charging. Stop the compressor upon reaching the proper gross weight. At this time, you have completed the recharging process, and you must secure the equipment.

10. To shut the equipment down, start by securing the inflation assembly valve, and shut off the compressor. Then secure the fill line valve. Open the relief valve; this will relieve any pressure you may have in the line between the fill line valve and the inflation assembly. Disconnect the fill line from the inflation assembly and remove the charging adapter. To secure the rest of the system, all you have to do is close the supply cylinder valve and bleed the system by opening the fill line valve.

If, during the recharging process, the cylinder being charged ceases to gain in weight, there may be one of two things wrong:

1. The supply cylinder may contain less than 10 pounds of carbon dioxide. In this case, a fully charged supply cylinder should be used and the partially charged cylinder reserved to start the recharging of an empty cylinder.

2. The connecting lines may have become stopped up with carbon dioxide snow. This may be caused by water in the supply cylinder or too small a valve passage (less than 1/8 in) in the supply cylinders. In this case, the disc assembly (disc-type valve) or the cylinder valve (seat-type valve) should be securely seated and the pump shut off. The connections should be broken and cleared of the carbon dioxide snow. The line will actually clear itself if allowed to stand for some length of time, but this can be hastened by applying a flame or torch to the tubing. The line should then be blown out with air to clear it of water or foreign matter.

### MAINTENANCE FOR THE C-O-TWO TRANSFER UNIT

Once every month, inspect the level of the oil in the crankcase and see that it is within the limits specified.

Once every 6 months, lubricate the idler shaft with two or three applications of light cup grease; also, lubricate the gear teeth with a thin coating of the same grease. With a small brush, apply a

light coating of Vaseline to the piston rod. To do this, dip the brush in Vaseline and hold the brush against the piston rod while rotating the gears manually until the piston rod has been coated completely. If necessary, tighten the packing at the piston stem. A special wrench is needed for this operation. Do not tighten excessively. Because of the design of the packing, it is necessary to make only a snug adjustment to have it hold tightly.

Keep the commutator or the motor clean. Under normal operating conditions, the commutator will require only occasional cleaning with a dry piece of nonlinting cloth. Never lubricate the commutator.

Drain and refill the crankcase at least once a year. The bearing housings of the motor, which also need attention at this time, should be cleaned and regressed by a qualified electrician. Use table 8-3 for servicing intervals.

### MAINTENANCE OF THE WALTER KIDDE TRANSFER UNIT

The instruction book on lubrication for the Walter Kidde transfer unit recommends inspecting the oil level in the crankcase periodically and changing it as necessary. Here, experience with pumps dictates the time of action. One can establish and maintain a schedule compatible with the experience gained through operating the equipment. The plunger packing needs no oil.

Table 8-3.—C-O-TWO Unit Servicing Intervals

ITEM CHECKED OR SERVICED	MONTHS		
	1	6	24
CRANKCASE OIL LEVEL	x		
IDLER SHAFT		x	
GEAR TEETH		x	
PISTON ROD		x	
PISTON STEM PACKING		x	
MOTOR COMMUTATOR		x	
DRAIN AND REFILL CRANKCASE			x
MOTOR BEARING HOUSINGS			x

